Appendix E

Noise Abatement Alternatives Analysis

Prepared by:
DMJM Aviation | AECOM
In association with:
Wyle
Portfolio Associates, Inc.
Appendix E
Noise Abatement Alternatives

E.1 Introduction

This section identifies potential noise abatement alternatives that may be evaluated for implementation for the improvement of the noise environment at PHL. Noise abatement alternatives are possible methods to reduce the effect of noise on the surrounding community. These alternatives consider modifications to aircraft movements on the ground, where and how aircraft conduct engine run-ups, and what routes aircraft fly over the ground, in order to reduce the effect of noise on the surrounding community.

The range of alternatives discussed in this section represents the standard range of alternatives evaluated in a Part 150 study and incorporates suggestions from the Study Advisory Committee, PHL DOA staff, and the public. In many cases, the concepts or procedures may not be suitable candidates for recommendation at PHL; regardless, Part 150 requires an evaluation of these alternatives. Advisory Circular 150/5020-1 indicates that, at a minimum, the following alternatives must be evaluated: denial of use to aircraft not meeting federal noise standards, capacity limitations based on noise, noise abatement procedures for arrivals and departures, noise-based landing fees, noise barriers or berms, acquisition of land, and curfews. Alternatives within the authority of the sponsor, within the authority of state and local agencies other than the airport, and within the authority of the Federal government should be evaluated.

The noise abatement alternatives identified in this section that appear to be suitable candidates for implementation are discussed in additional detail, and are identified as candidates for inclusion in the Sponsor's recommended Noise Compatibility Program. Following the identification and evaluation of suitable noise abatement alternatives, efforts were focused on remedial land use alternatives to reduce remaining incompatibilities, preventive land use alternatives to prevent future incompatibilities, and program management alternatives. Land use alternatives (remedial and preventive) are discussed in Appendix F. Section 6 and 7 identify PHL’s recommended Noise Compatibility Program including all noise abatement, land use, and program alternatives, and provides implementation details for each.

Range of Alternatives

Through consultation with the Study Advisory Committee, a series of alternatives was developed that represented the range of potentially feasible methods that would be evaluated in the study. The range of alternatives, each identified by a letter, is as follows:

- NA-A: Extend Runways
- NA-B: Displace Runway Thresholds
- NA-C: Runway 35 Departures
- NA-D: Preferential Runway Use
- NA-E: Continuous Descent Approaches (CDA)
- NA-F: Restrict Nighttime Operations
- NA-G: Modify Nighttime Runway Use Program
- NA-H: Restrict operations by type/Noise level
- NA-I: New Runway Construction
- NA-J: Maximize use of River Corridor
- NA-K: Runway 27L & 27R Departures

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Noise Compatibility Program Update

- NA-L: RNAV (Advanced Navigation) Procedures
- NA-M: Maximize use of Runway 27L
- NA-N: Construct Noise Barrier
- NA-O: Restrict use of Reverse Thrust
- NA-P: Restrict use of Auxiliary Power Units
- NA-Q: Raise altitude at MRTIN (formerly KIRDE) & BWINE
- NA-R: Utilize 3.0 degree glide slope on approach
- NA-S: Minimize thrust/drag configurations
- NA-T: Intercept extended centerline at 3,000 feet
- NA-U: Runways 09L/09R/17/35/08 Noise Abatement Procedure
- NA-V: Runway 27L Noise Abatement Procedure
- NA-W: Runway 27R Noise Abatement Procedure
- NA-X: Maintenance Run-Up Restrictions
- NA-Y: Noise Attenuation in New Building Construction

E.2 Noise Abatement Alternatives Analysis

Extend Runways (Alternative NA-A)

A runway extension allows for the possibility of reducing noise impacts as a result of aircraft overflights. A runway extension could allow aircraft to depart, and therefore become airborne, at a point further from the end of the runway, possibly resulting in an increased altitude (and reduced noise levels) above noise-sensitive development. At PHL, no significant impacts, as defined by Part 150, exist resulting from aircraft operations on Runways 09L/27R, 09R/27L, or 8/26. Significant impacts do, however, exist in the residential area north of Runway 17/35 in the City of Philadelphia. A runway extension to the south could have the potential to raise the altitude of aircraft departures over the neighborhood of Eastwick.

Lengthening the distance from the beginning of a departing aircraft’s application of engine thrust and the nearest noise-sensitive receiver could reduce single event noise levels, by allowing aircraft to climb higher over the same noise-sensitive receiver. A runway extension to Runway 17/35, if feasible, could increase the altitude of aircraft departures over the Eastwick neighborhood in the City of Philadelphia, thereby potentially reducing the number of noise sensitive facilities within the DNL 65 dB noise contour. Further extending Runway 17/35 could increase the potential for larger aircraft to utilize the runway, and could have a capacity benefit. However, Runway 17/35 was analyzed through the Runway 17/35 Environmental Impact Statement and has subsequently been extended to the maximum extent possible. The distance that the runway was extended to the south was modified due to the location of the Runway Safety Area (RSA) in relation to the airport fence line and perimeter road.

In general, an extension of a runway should have tangible noise and cost benefits. While noise may be reduced as a result, any additional lengthening of Runway 17/35 would 1) allow larger and potentially louder aircraft to use the runway, and 2) accumulate costs that would likely exceed the costs of mitigating the noise-sensitive residences in Eastwick. Further, an extension to Runway 17/35 was studied, which resulted in the construction of additional runway bringing the current length to 6,500 feet. No additional land is available to further extend the runway to the north or the south.

As such, Runway 17/35 is considered fully extended and operates with ATCT limitations. The ongoing CEP is evaluating future runway layout options, including extensions to the parallel runways. Alternative NA-A was not recommended for further evaluation.
Displaced Thresholds (Alternative NA-B)

A displaced threshold, for either arrivals or departures, reduces the length of runway available for landing or departure. Runway thresholds may be displaced for a number of reasons, including line-of-sight issues with the ATC, obstacle clearance, or noise abatement. Potentially, displaced thresholds may be utilized to increase the altitude of aircraft over noise-sensitive locations directly in the vicinity of aircraft flight tracks.

A displaced threshold for arrivals would imply that aircraft touchdown on the runway at a point down the runway from the physical end of the pavement. From a noise perspective, this may be beneficial as it could increase the altitude of approaching aircraft over noise sensitive areas along the approach path. Additionally, a displaced threshold for arrivals may also increase the distance between the aircraft and the noise-sensitive receiver, at the point where reverse thrust is applied. The amount of noise reduction is directly related to the length of the displaced arrival threshold. Notably, shortening the length of available runway, for either arrivals or departures, has the potential to decrease safety, especially in periods of adverse weather or reduced visibility.

No significant impacts exist resulting from aircraft operations on Runways 09L/27R, 09R/27L, or 8/26. Significant impacts do, however, exist in the residential area north of Runway 17/35 in the City of Philadelphia. A displaced threshold for Runway 17 arrivals (arrivals which overfly Eastwick in a south direction) could have the potential to raise the altitude of aircraft arrivals over the neighborhood of Eastwick. A displaced threshold of approximately 1,000 feet could provide about one dB of reduction, which is typically not detectable by the human ear. It is not feasible, however, to implement a displaced threshold for Runway 17 arrivals. Currently, the glide slope is increased to provide safe clearance to nearby roadways, and the approach lighting system to the runway is shortened to avoid impacting the historic firehouse.

Displaced thresholds could increase the altitude of arriving aircraft over noise-sensitive facilities further from the airport, however the noise reduction is minor and beyond the DNL 65 dB. Further, navigation equipment for arrivals to Runway 17 is already altered to address existing obstacles. Alternative NA-B was not recommended for further evaluation.

Runway 35 Departure Procedures (Alternative NA-C)

Aircraft activity on Runway 17/35 accounts for the area of significant impacts within the DNL 65 dB noise exposure contour in Eastwick. Specifically, arrivals to Runway 17 and departures from Runway 35 contribute to noise in this area. Runway departure headings from Runway 35 were evaluated to determine whether any potential changes to the noise exposure contour which would reduce the number of noise-sensitive land uses within the DNL 65 dB noise contour where feasible. Specifically, Runway 35 departures that departed the runway and either turned to a west heading or flew the runway heading were evaluated. The utilization of the compatible land use corridor to the northeast of the runway was considered.

Two scenarios were evaluated to identify potential improvements. A small number of departures from Runway 35 depart the runway and turn right to reach their first navigation points (Woodstown, Coyle VOR). These turns were modified to occur directly upon departure, thus moving the ground track over the compatible land use corridor along Essington Avenue. Because of the small number of operations that this impacted (approximately 5 on an average annual day), marginal changes to the noise exposure in this area would be realized.

The second scenario evaluated shifting departures from Runway 35 that fly runway heading to utilize the same compatible land use corridor along Essington Avenue prior to turning towards their destination. This shift included a more notable amount of all Runway 35 departure traffic. This change did impact the shape and distribution of noise in Eastwick.

Noise Abatement Alternatives
Following this initial analysis, conversations with the PHL ATCT took place to evaluate the feasibility of each. Although the possibility to move flight tracks into a compatible land use corridor exists, traffic to other runways must also be considered. According to the PHL ATCT, right hand turns to Woodstown and Coyle do not occur with the frequency they once did. Arrival traffic to Runway 35 from the north flies directly east of the airport at low altitudes on approach. Moving the departure flight activity from Runway 35 would conflict with these arrivals, and cause the displacement of this traffic to another runway. The revised flight tracks could be used, however the departing traffic would be required to maintain a low altitude to provide for the safe vertical separation between flows of air traffic. Maintaining these departures at a low altitude would increase noise impacts in other areas.

There are a number of drawbacks associated with this alternative. Primarily, the increase in air traffic controller workload and decreased margins of safety associated with Runway 35 arrivals to the east of the airport would not be supported by the ATCT. Additionally, requesting straight out departure aircraft whose destination is to the west to first turn east prior to turning on course, combined with the need to maintain low-level altitudes, would increase fuel costs. Right-hand traffic turns could cause conflict with the downwind approach to Runway 35 arrivals. With additional traffic, some departures would need to be held at lower altitudes, thus increasing noise impacts. The implementation of these procedures would result in increases in pilot and ATC workload for coordination, and increased fuel costs to airlines flying to the west/northwest. As such, Alternative NA-C was not recommended for inclusion in the recommended NCP.
Preferential Runway Use Program – Reduce the Use of Runway 17/35 (Alternative NA-D)

Preferential runway use, in the context of noise management, is described as the prioritized selection of specific runways designed to minimize the frequency of overflights over non-compatible land uses in the vicinity of an airport. Preferential runway use works to minimize the number and severity of aircraft overflights of noise-sensitive land uses by directing aircraft to use specific runways when conditions permit. Reducing the number or severity of overflights over noise-sensitive land uses may or may not reduce the cumulative DNL levels; however, it could provide single event over-flight relief. Preferential runways may only be feasible under specific wind conditions and during specific periods of lower demand on the available runways. Use of prioritized runways may potentially increase taxi time and increase track miles for a particular flight.

Runway use programs are either voluntary (informal) or mandatory (formal). A formal preferential runway use program may be considered a limitation and may be subject to a Part 161 analysis. It is also subject to a formal Letter of Understanding between all users, including the FAA, airport proprietor, tenants, and ATCT. Voluntary, or informal, runway use programs are typically easier to implement, as they rely on consultation and understanding between the airport proprietor, individual tenants, and the ATCT and are generally indicated in a Tower Order. FAA Order 8400.9 provides additional detail regarding operational criteria for runway use programs.

There are a number of opportunities that can be pursued by an airport to improve the use of preferred runways. Beyond constructing new runways, there may be navigation improvements that can increase the use of specific runways. For example, installing an ILS on the preferred noise compatible runway may allow additional aircraft to use that runway in more weather conditions. Generally, the designation of preferred runways for noise compatibility does not have associated costs to the airport. Additionally, airlines may incur additional fuel costs resulting from increases in taxi distances or increased track miles flown.

At PHL, use of Runways 09L/27R and 09R/27L maximizes the overflight of compatible land use. This alternative would limit the use of Runway 17/35 to reduce noise exposure in Eastwick by moving traffic to Runways 09R/27L, 09L/27R, and 08/26 through either a formal or informal runway use program. Reducing aircraft activity on Runway 17/35 would reduce single event noise levels, and could reduce the area of significant noise exposure (DNL 65 dB). Pursuit of this alternative discounts the recently completed EIS that extended Runway 17/35 to ease capacity constraints. Because of the need to use Runway 17/35 by various operators, Alternative NA-D was not recommended for further evaluation.

Continuous Descent Approaches (Alternative NA-E)

Arrival procedures at major airports typically utilize a “step down” method, whereby an aircraft gradually descends then levels off and maintains that altitude until air traffic control instructs the aircraft to descend again. While this procedure assists air traffic control in maintaining safe separation between aircraft, when an aircraft must level off the aircrew must make adjustments to flap and thrust settings, thereby potentially using more power to maintain level flight, increasing noise, fuel burn, and emissions. The use of a CDA allows an aircraft to perform a continuous descent at idle power from a high altitude to glide slope intercept on the final approach to the runway. While ICAO is currently working on a manual to standardize CDAs, currently there is no agreed upon international procedural definition of a CDA; however the intent of the procedure is to reduce the segments of level flight that cause thrust variations that in turn cause noise impacts over land. An increase in the distance between source and receiver (airplane and ground) coupled with idle power settings on descent can produce a reduction in noise exposure under the approach path prior to glide slope intercept.

The use of CDA procedures requires onboard Flight Management System (FMS) for a managed idle descent and is most effective when aircraft are also RNAV capable for lateral trajectory management. While most newer aircraft are equipped, older aircraft may require upgrades to meet minimum required
performance. The benefits of CDAs extend beyond noise abatement and includes reduced emissions and fuel burn, hence, providing an economic benefit to the air carriers. The reduced engine stress produced by idle thrust approaches may also contribute to lower maintenance costs during the life cycle of aircraft engines. The most significant constraint to CDA implementation lies in the efficient sequencing and separation of aircraft within Terminal airspace. Without additional automation, uncertainty in scheduled time of arrival and variations in aircraft performance characteristics and equipage can challenge air traffic control’s ability to maintain a steady CDA flow without the imposition of speed and altitude adjustments.

In North America, the Partnership for Air Transportation Noise and Emissions Reduction (PARTNER) conducted the first full test of a CDA procedure at Louisville International Airport, utilizing United Parcel Service aircraft in 2002. The tests at Louisville International Airport produced noise reductions of approximately 30%, or about 6-dBA noise reduction below 6,000 feet with the most notable reductions in single event noise levels at distances of 7-15 nautical miles from the runway end. CDA implementation highlights around the world:

- In 2002, the first major US test of the procedure was completed at Louisville International Airport, in conjunction with United Parcel Service (UPS). Approximately 25% of UPS fleet is expected to conduct CDA approaches at Louisville International Airport by the end of 2008.
- UPS also utilizes CDA approaches at Sacramento Mather Airport in California, which was the first airport to fully implement the procedure in early 2006. Mather Airport uses CDAs as a noise abatement measure during night-time hours.
- In December 2007, Los Angeles International Airport (LAX) implemented a CDA procedure for flights arriving from the east. According to LAX, approximately 250 arriving aircraft use the CDA every day, resulting in an estimated 30% reduction in noise and emission levels at the airport.
- The European Regions Airline Association (ERA) has called for the use of CDAs at as many European airports as possible. ERA now plans to work closely with Eurocontrol to promote the implementation of CDAs at regional airports throughout Europe through collaboration with airlines, airports and air traffic service providers.
- British Airways reports that it is achieving a 95% compliance rate with CDA procedures at Heathrow and Gatwick airports.

Continuous descent approach procedures are still in the early stages of development, and are not yet anticipated to be implemented on a large, nation-wide scale. However, as part of the New York/New Jersey/Philadelphia Airspace Redesign Program (ARD), the use of continuous descent approach procedures was included as part of the noise mitigation plan at PHL.

At this stage, CDAs are generally used during periods of low aircraft activity, often at night. Many aircraft already have the capability to fly CDAs, and as older fleets are replaced with new aircraft, the number of aircraft able to fly new approaches will increase. A study of airspace operations would help determine the best way to design and implement a new approach at the airport, as well as discussing the development of CDA’s with airports that already use the approach. This will require the cooperation of air carriers, airport officials, air traffic control, and the government to develop and design a CDA approach. Since the implementation of CDA procedures is already anticipated to occur, PHL should support the FAA, ATCT, and aircraft operators to quickly implement procedures that may have specific noise benefits. Alternative NA-E was recommended for inclusion, and is further discussed as Measure NA-7.

Restrict Operations based on Noise Levels or Number of Operations (Alternative NA-F)

In the United States, there are a number of operating restrictions that are in place at airports that act, either indirectly or directly, to limit the noise caused by aircraft activity on the ground or in the air. Some activity restrictions have been in place for decades, while others are pursued through other planning and investigative means. Part 150 identifies basic categories of noise-based restrictions that should be evaluated during the course of a Part 150 study. Included among these are usage restrictions that would limit either the total number of operations, the number of operations by an aircraft’s relative amount of
noise generated, or restrictions on the number of operations based on the time of day. The aim of these restrictions is to reduce the number of aircraft overflights at an airport in order to provide noise relief to residents and noise-sensitive facilities in the areas surrounding the airport.

In an effort to minimize congestion and reduce delays at some of the United State’s busiest airports, in 1968 the FAA issued the High Density Rule (HDR). The HDR (or slot rule, as it is commonly referred to) limited aircraft operations that could occur each hour at specific airports: Chicago O’Hare, DCA, JFK and LGA. At the time, each of these airports was quite congested, and implementation of the slot rule limited the number of arrivals and departures that could occur in an hour. The HDR addressed specific hours of concern at each of the airports, for example, at JFK, where five hours of peak transatlantic demand (between 3:00 p.m. and 8:00 p.m.) was slot-controlled. Since 1968 the hourly number of commercial takeoffs and landing slots at DCA slots has been controlled by the Federal government. DCA is subject to the provisions of 14 CFR Part 93 Subpart K—High Density Traffic Airports, which limits the number of operations to preclude excessive delays that occur at several U.S. airports where demand for aviation services exceeds the physical capacity of the airport during certain operating hours. Reducing the number of aircraft operations that can occur in a time period does have the effect of limiting cumulative and single-event noise levels during those periods, but has historically been implemented to address capacity, rather than noise.

In 1990, Congress passed the Airport Noise and Capacity Act (ANCA). ANCA set the timeline for the phase-out of Stage 2 aircraft and limited the ability of local airport operators to impose restrictive actions at an airport. Conditions imposed on a proposed Stage 3 aircraft restriction, as outlined in Part 161 – Notice and Approval of Airport Noise and Access Restrictions, instituted in 1991, include that the proposed restriction is reasonable, non-arbitrary, and non-discriminatory; does not create an undue burden on interstate or foreign commerce; maintains safe and efficient use of navigable airspace; does not conflict with any existing Federal statute or regulation; has had sufficient opportunity for public comment; and does not create an undue burden on the national aviation system.

To date, only one airport has successfully completed a Part 161 study. Further, in late 2007, the FAA issued its notice of intent to revise Advisory Circular 150/5020-1, Noise Control and Compatibility Planning for Airports. The intent of the revised AC, which is anticipated to be published in 2010, is to incorporate changes in policy, guidance, and other changes to both Federal law and 14 CFR Part 150 that may have occurred following the publication of the original AC in 1983. It is expected that a significant update to the AC will include guidance pertaining to usage restrictions.

Access restrictions could reduce the size of the noise exposure contour at PHL. Access and user restrictions are often the most difficult types of measures to implement, as they require the successful completion of an FAR Part 161 study. Further, based on the noise levels anticipated to occur in 2013, neither restricting the number of operations or operations by noise level would be anticipated to reduce significant impacts. As such, Alternative NA-F was not recommended for further evaluation.

**Restrict Nighttime Operations (Alternative NA-G)**

Many airports in the United States have notable nighttime activity, whether from passenger arrivals and departures or cargo operations, and PHL is no exception. Approximately 12% of all PHL operations are expected to occur during the nighttime hours (10:00 p.m. to 7:00 a.m.) in 2013. Nighttime activity at PHL primarily consists of the conclusion of a passenger aircraft departure “push”, occasional aircraft arrivals, and cargo operations.

A restriction of nighttime activity at PHL would not significantly impact the projected 2013 noise exposure contour, as the only areas of significant noise exposure over noise-sensitive land uses occur in the neighborhood of Eastwick. Aircraft activity on Runway 17/35 is limited during nighttime hours, and the Airport maintains a voluntary informal nighttime runway use program designed to minimize aircraft overflights over noise sensitive areas between 11:00 p.m. and 6:00 a.m. Further, placing limits on
nighttime activity at PHL would require a Part 161 study, which would be unlikely to be approved based on past precedent. This alternative was not further analyzed under this study.

Restrict Operations by Aircraft Type/Noise Certification Level (Alternative NA-H)

Many airports have, historically, limited aircraft operations based on noise levels. The United States defines noise levels of aircraft by stage, which closely follows the ICAO “chapter” designation. Airports rely on the Federal government to lead the charge in reducing noise at the source by way of continued evaluation of noise certification standards and phase out schedules. The Noise Control Act of 1972 amended the Federal Aviation Act, giving the FAA authority to set limits for aircraft noise emissions. This is implemented by Federal Aviation Regulations (FAR) Parts 91 and 36 which set limits on noise emissions for newly designed and/or newly produced aircraft and required phase out of the noisiest heavy transport class aircraft by January 1, 1985. FAR Part 36 - Noise Standards: Aircraft Type and Airworthiness Certification was released in 1974 and certifies aircraft based on measured noise levels.

To date, only one airport has successfully completed a Part 161 study. Further, in late 2007, the FAA issued its notice of intent to revise Advisory Circular 150/5020-1, Noise Control and Compatibility Planning for Airports. The intent of the revised AC, which is anticipated to be published in 2010, is to incorporate changes in policy, guidance, and other changes to both Federal law and 14 CFR Part 150 that may have occurred following the publication of the original AC in 1983. It is expected that a significant update to the AC will include guidance pertaining to usage restrictions.

Access restrictions could reduce the size of the noise exposure contour at PHL. Access and user restrictions are often the most difficult types of measures to implement, as they require the successful completion of an FAR Part 161 study. Numerous operators at PHL have reduced the number of older, noisier aircraft from their fleet during this period of reduced operations. Further, based on the noise levels anticipated to occur in 2013, restricting operations by noise level are not expected to reduce significant impacts. As such, Alternative NA-H was not recommended for further evaluation.

Runway Construction (Alternative NA-I)

Similar to the analysis completed for Alternative NA-A (runway extension), the construction of additional runways could potentially modify the size and shape of the noise contour. However, in order to be approved under Part 150, the benefits of runway construction must outweigh the costs of mitigation. Further, the ongoing CEP is evaluating future runway layout options, including extensions to the parallel runways and the construction of an additional parallel runway. Because of the extent of anticipated significant impacts at PHL in 2013, and the ongoing analysis of potential future runway construction, Alternative NA-I was not recommended for further evaluation in the NCP.

Maximize the Use of the River Corridor (Alternative NA-J)

Because of the orientation of PHL’s primary runways and the Delaware River, efforts to maximize the use of the river corridor have been considered in this and previous studies at PHL. Methods to increase the use of the river corridor include:

- RNAV departure procedures
- Increased use of the existing visual river approach
- RNAV river approach
- Cargo operators to increase their use of the river approach during overnight hours

Increased use of the river corridor could bring single-event noise reductions. However, of the methods identified above, none are anticipated to result in a noise benefit within the DNL 65 dB noise exposure contour.
Alternative NA-K evaluates Runway 27L and 27R departures  
Alternative NA-L evaluates RNAV procedures  
Alternative NA-M evaluates maximizing the use of Runway 27L

No specific strategy identified in this alternative was recommended for further analysis. Rather, a series of additional alternatives, as outlined above, were evaluated. PHL should continue to support the FAA’s continued development of advanced navigation techniques and should continue to work with the airlines and users to take full advantage of these procedures.

**Modify Departure Headings from 27L and 27R (Alternative NA-K)**

This alternative evaluates the possibility of modifying the flight tracks used by aircraft departing Runways 27L and 27R. By 2013, all of the dispersed headings resulting from the implementation of the ARD are anticipated to be in place for departures during both east and west flow. During west flow (departures from Runways 27L and 27R), aircraft will depart and fly runway headings of 268 degrees, 245 degrees, and 230 degrees during the times the ARD headings are in place, and the traditional 255 degree river departure during other times.

This alternative looks at ways of minimizing the impacts of the four headings used by jet aircraft to the west of PHL. Potential scenarios such as the implementation of RNAV departure procedures, changing the heading direction, and modifying the hours of use of specific departure headings are under consideration.

- Modifying the hours of ARD departure headings: This scenario cannot be implemented, as the Record of Decision for the ARD dictates the times in which the headings are in place. It does, however, specify that after 10:00 p.m. and before 6:00 a.m., the ARD departure headings are not in use, and the airport will operate following the traditional river departure heading.
- Modify heading directions: Due to safety concerns, fanned departure procedures such as that implemented by the ARD require 15 degrees separation between departure headings. Further, the noise mitigation efforts undertaken by the ARD team evaluated a number of potential combinations of headings to determine the minimum number of headings required to meet capacity and safety goals.
- RNAV Departure Procedure Implementation: Often RNAV departure procedures have the potential to reduce the distribution of noise along a specific flight track by reducing the effect of wind and weather conditions on pilot navigation. Essentially, RNAV procedures allow for the direct navigation to a point in space rather than a ground-based navigation aid. As such, RNAV procedures focus noise exposure along a narrower path over the ground. RNAV procedures are currently under development by the FAA and are anticipated to be implemented before the 2013 timeframe.

It should be noted that no significant impacts (noise sensitive land uses within the DNL 65 dB noise contour) exist to the west of PHL, along the departure and arrival corridor. However, potential single event noise benefits and a reduction in noise exposure beyond the DNL 65 dB noise contour prompted PHL to evaluate this alternative. As is currently the operating condition, the PHL ATCT anticipates that propeller aircraft departing Runways 27L and 27R will continue to follow ATCT direction and often turn towards their destination earlier than jet aircraft, which are considerably faster. RNAV procedures are further discussed in Alternative NA-L, and recommended measures NA-1, NA-2, and NA-3 reflect the updated departure procedures. No other aspects of Alternative NA-K were recommended for further analysis or inclusion in the NCP.
RNAV Procedures (Alternative NA-L)

Traditionally, aircraft navigation is performed using visual references on the ground, or by a series of ground-based navigation equipment. First developed in the 1960’s, Area Navigation (RNAV) is a method of navigation that allows an aircraft to choose any course within a network of navigation beacons, as opposed to flying direct paths between navigation aids. The ability of an aircraft to fly point-to-point allows for shorter routes, an increase in safety, reduced controller workload, and the use of less fuel, as well as the potential to reduce noise impacts.

Required Navigation Performance (RNP) is method for measuring locational accuracy in airspace, or RNAV with performance monitoring and altering capability. RNP monitors the reliability of navigation systems and informs the aircraft crew if certain requirements are not met. The capability of the system to monitor and alert enhances the crew’s situational awareness and could reduce obstacle clearance and route spacing. RNP operations require special training for the crew, and RNP equipped aircraft can operate in inclement weather at terrain-challenged airports and within close proximity of a parallel runway. This level of accuracy allows for reduced spacing, which thereby increases capacity, without derogating safety.

Area Navigation relies on the use of a sophisticated Flight Management System (FMS) in an aircraft. FMS is an integrated system that provides a centralized control system consisting of location information, navigation, fuel flow data and atmospheric data for flight planning and management. The FMS is essentially a computer containing sensor input data and a navigation database that includes navigation aids, waypoints, and airports. An aircraft must be equipped with an appropriate FMS that is capable of flying the desired approach. An onboard FMS would allow aircraft to fly curved flight tracks avoiding non-compatible land uses around an airport.

The Airspace Redesign study evaluated changes to existing and proposed flight path locations that could benefit the noise environment. This included the enhancement of existing departure procedures from the two primary runways (Runways 09L/27R and 09R/27L) by utilizing RNAV procedures to define a specific location at which aircraft could commence turns, rather than a prescribed altitude, which varies by a number of variables including the type of aircraft, wind and weather conditions, and other factors. While the study identified potential noise benefits associated with these procedures, it also identified barriers to their implementation, including the acknowledgement that not all aircraft were equipped to take advantage of RNAV procedures and that each would require additional FAA coordination, environmental approval, and ATCT training.

The Airport and the PHL Noise Abatement Program Manager’s roles are limited as far as implementing RNAV procedures. The FAA is continuing the implementation of advanced navigation procedures, and has published internal guidelines regarding the development of RNAV procedures for use by its RNAV Implementation Working Group. The 2003 Part 150 study and the ARD both identified many potential RNAV overlays, and the FAA is implementing these over time. This alternative is further evaluated in Measure NA-5.

Construct Noise Barrier (Alternative NA-N)

Noise barriers are often an effective means of reducing the impact of specific aircraft ground noise. Noise barriers typically include earthen berms, constructed walls, trees, vegetation, or other types of acoustic shielding, and are designed to mitigate the effects of aircraft noise due to taxiing operations, departure roll-out, engine maintenance and run-ups, and the use of reverse thrust on arrivals. Generally, noise barriers are built on airport property or nearby compatible land uses, similar in design to those commonly seen along various types of roadways.

A typical noise barrier design is based on the type of noise source of concern, plus such factors as the physical characteristics of the surrounding landscape, height restrictions per FAR Part 77, and the physical characteristics of the barrier. The intent of a noise barrier to is block the line of sight between a
source and a receiver since sound travels primarily in a straight line; however, the more forces that act upon the sound energy (such as wind, reflection off of buildings, etc) the less effective a barrier will be. In order for a barrier to be effective, it must be close to either the source or the receiver. Height is also a factor; i.e., the taller the barrier, the more effective at greater distances. In order to be effective, the line of sight between the source and receiver needs to be blocked, so noise-sensitive uses that are high enough to have line of sight to the aircraft noise source would not experience the any shielding benefits. Terrain also plays an important role in the performance of a noise barrier.

This alternative was first identified in the 2003 FAR Part 150 program. The alternative identified potential locations designed to reduce the transmission of ground noise to neighboring noise-sensitive land uses. However, due to the location and restrictions of ground run-ups already in place at PHL, it was not included in the NCP.

One potential location for a noise barrier, as suggested in Public Workshops, is located in an area adjacent to the old Westinghouse Plant between Powhattan Avenue and the Delaware River. A noise berm in this area would potentially reduce the transmission of noise to the Lester/Essington area. While noise barriers have the potential to reduce noise levels from ground noise, other alternatives addressed in this Part 150 may accomplish the same goals (evaluating the location of ground run-ups, reducing the use of reverse thrust, etc). Depending on the noise source, berms/walls/barriers could provide 5-10 dB reduction in sound levels in noise-sensitive areas surrounding PHL.

The greatest drawback to the use of a barrier is that they are only effective when the source of the noise is on the ground – i.e. barriers do not mitigate aircraft overflights. In addition, as the distance between the source and receiver increases, the effectiveness of a noise barrier decreases (however the noise level is lower by half for each doubling of distance between the source and receiver). Some studies show that noise barriers do not provide as much mitigation to low frequency aircraft noise.

Due to the location of significant impacts around PHL (in the neighborhood of Eastwick), the construction of a berm would not be expected to decrease noise impacts in that area. As such, this alternative was not recommended for further evaluation. However, should PHL decide to pursue further analysis, a preliminary step would be the completion of a feasibility study which would further define the type, length, height, width, and location of the potential noise barrier, and would attempt to quantify noise reduction levels that could be expected in certain locations. If the barrier proved effective, PHL would move forward to design and construct the barrier. A feasibility study could cost $25,000 to $75,000, while construction costs could vary widely depending on the final construction specifications, and any associated land acquisition costs.

Restrict the Use of Reverse Thrust (Alternative NA-O)

Upon touchdown on a runway, aircraft immediately begin decelerating. Primarily, and according to regulations, aircraft must be able to safely stop on the runway with only the use of friction breaks located on the landing gear. However, aircraft often utilize reverse thrust upon arrival, which, in some cases, can reduce the stopping distance by as much as one third of the runway. The use of reverse thrust is beneficial for a number of reasons, such as the safety improvement associated with decelerating the aircraft as quickly as possible, holding short and exiting the runway prior to an intersecting taxiway or runway, and to improve safety in adverse weather conditions.

Essentially, the use of reverse thrust is engaged manually by the pilot, and consists of a system which redirects engine thrust towards the front of the aircraft. In conjunction with the use of brakes and flap settings, these methods sufficiently slow the aircraft to the point where turns from the runway to a taxiway can be completed safely.

Airports engage in a number of strategies to reduce the impacts of the use of reverse thrust by aircraft, and a number of factors influence the pilot's decision to use reverse thrust. As a matter of safety, the pilot should always have the option of utilizing reverse thrust to maintain the safe operation of the aircraft.
However, the use of reverse thrust may not always be necessary. When runway conditions are dry, and sufficient runway length is available, pilots may be discouraged from using reverse thrust. Airports can facilitate the reduction of the use of reverse thrust by designing the runway and taxiway layout with high-speed taxiway exits. Especially during nighttime arrivals, an airport can designate a primary arrival runway that puts the greatest distance between the runway in use and nearby non-compatible land uses. Finally, depending on the location of the noise sensitive community to runway, the use of berms and walls can be an effective means of mitigation for reverse thrust noise. Pilot awareness programs and noise berms are evaluated in this analysis. PHL also maintains a series of high-speed taxiway exits on Runways 09L/27R and 09R/27L. Because this alternative does not meet the goals of Part 150, it is not recommended for further evaluation as a stand-alone measure, however, efforts by PHL to encourage reducing the use of reverse thrust are further evaluated in the Airport’s Fly Quiet program.

Raise altitude at MRTIN (formerly KIRDE) & BWINE (Alternative NA-Q)

As aircraft approach PHL for arrival, they intercept navigation points located approximately 10-15 miles from PHL. Arrivals approaching PHL from the west intercept the BWINE intercept, approximately 15 miles from PHL, over the Brandywine Hundred and Arden, Delaware area, and arrivals approaching PHL from the east intercept the MRTIN navigation point over the Haddonfield area in New Jersey.

Suggestions were made to evaluate the feasibility of raising the altitude of aircraft at MRTIN and BWINE. Increasing altitude of approaching aircraft could have the potential to reduce noise levels. To the east, implementation of this alternative could result in notable airspace limitations due to aircraft arrivals to Runway 35, which overfly the same area at higher altitudes. Further, aircraft flying visual approaches generally turn towards the runway at various locations, depending on their origin, including locations closer to the runways than MRTIN. ATC may need to separate aircraft by altitude prior to arriving at MRTIN. Raising the intercept altitude in this area by 1,000 feet could have the potential to decrease single event noise levels, but at levels that would be difficult to perceive. Further, there would be no benefit to noise levels within the DNL 65 dB noise contour.

Historically, aircraft overflew this area at an altitude of 1,700 feet, however, this altitude was raised by the FAA. To the west, aircraft on an instrument approach to Runways 09L and 09R intercept the BWINE navigation fix at either 4,000 feet or 3,000 with ATC permission. As part of this study, suggestions were made to further increase the altitude of aircraft intercepting the navigation fix. Historically, arrivals to Runways 09L/09R occur when the airport is in east flow, which occurs approximately 20% annually. Raising the intercept altitude at BWINE could have the potential to decrease single event noise levels, but at levels that would be difficult to perceive. Further, there would be no benefit to noise levels within the DNL 65 dB noise contour.

Restrict use of Auxiliary Power Units (Alternative NA-P)

Most passenger and cargo aircraft are equipped with auxiliary power units (APU), which provide power to an aircraft at a gate or on the ramp. The primary use of an APU is to provide startup power to the aircraft’s main engines. Secondarily, APUs are utilized at the gate or on the ramp to power the aircraft’s electrical, ventilation, and in some cases the hydraulic systems. The benefit of using the APU is that it precludes the need to start an engine to power these systems, as APUs are often smaller and require less fuel.

One of the most significant drawbacks to the use of an aircraft APU is fuel burn. At a gate or parking position, especially during periods of low activity, APU usage may cause noise disturbances to the surrounding community. Additionally, usage of an aircraft’s APU on the ground increases its total operating time, which increases maintenance needs and potentially, the reliability of the APU for required in-flight backup services.
As a measure to both reduce emissions and to provide better service to its tenant airlines, many airports have begun installing gate electrification systems, ground power units (GPU), and preconditioned air systems to provide sufficient power and ventilation requirements for the aircraft.

- Zurich International and Narita International Airports limit APU usage to five-minute windows upon arrival and prior to departure.
- Madrid-Barajas Airport has restrictions on APU use for various gate groups and ramp areas. The airport bans the use of APUs at the gate during the night-time hours.
- BAA Stansted (London, UK) requires the use of fixed electrical ground power for all aircraft at gates, as opposed to APUs or mobile power sources.

A reduction in the use of aircraft APUs would reduce the cumulative noise environment from ground operations at an airport. Studies have been conducted which quantify noise from specific APUs; however, any noise reduction benefits associated with reduced APU usage would in general be small to the overall airport noise exposure footprint. A more notable benefit to both airlines and the surrounding community is the reduction in emissions associated with the use of APUs. Airlines can save money by reducing the amount of fuel used and the amount of wear and tear on the APU. Compared with an APU, use of a GPU has resulted in a dramatic drop in CO2 emissions. For example, an APU on board a wide-body jet emits approximately 1 ton of CO2 per hour of use compared to approximately 80-90 kilograms of CO2 from a GPU - a reduction of more than 90%.

In some cases, the turn-around time for an aircraft may conflict with the time necessary for the utilization of ground power sources. As such, it may be more efficient from an airline scheduling perspective to continue to utilize the aircraft’s APU. In some instances, air carriers have also cited the insufficient power or air supplied by the gate systems as a reason for opting to continue use of their APUs.

PHL has been ambitious in its efforts to install preconditioned air and gate electrification at all of its gates. Further, the noise levels produced by aircraft utilizing APUs is not expected to cause significant impacts to surrounding noise sensitive land uses. Because this alternative does not meet the goals of Part 150, it is not recommended for further evaluation as a stand-alone measure, however, efforts by PHL to encourage the reduction in use of APUs are further evaluated in the Airport’s Fly Quiet program.

**Utilize 3.0 degree glide slope on approach (Alternative NA-R)**

Aircraft arrivals utilizing an Instrument Landing System (ILS) follow an electronic signal that places the aircraft on a standard descent approach path towards the runway. FAA regulations allow the glide slope, in some cases, to be adjusted 0.5 degrees higher or lower than the standard 3 degree glide slope. Increasing this approach angle could increase the altitude of aircraft over potentially noise-sensitive development along the approach path. Increasing the glide slope angle also increases the speed in which an aircraft would land, which has the potential to erode safety. This increase in altitude has the potential to reduce aircraft overflight noise in areas further from the airport. As sound transmission generally decreases at about 6 dB per doubling of distance, the slight increases in altitude gained by increasing the glide slope to 3.5 degrees would be less than 1 dB, which is not typically noticeable by the human ear. As this would affect areas beyond the DNL 65 dB noise contour, it is beyond the scope of Part 150 and not recommended for further evaluation.

**Minimize thrust/drag configurations (Alternative NA-S)**

Noise from aircraft overflights is caused by engine thrust levels and also by airframe noise, consisting of the aircraft’s flaps and landing gears. Reducing noise levels of departing aircraft would involve reducing the power settings use throughout the takeoff roll (on the runway) and during the aircraft’s climb. An aircraft’s ability to fly a reduced thrust departure depends on the weight of the aircraft, wind and weather conditions, the condition of the pavement, and the length of runway. Over time, airlines have developed unique standardized departure procedures for aircraft types. In order to protect margins of safety, the
FAA has identified two standard departure procedures, one representing a “close in” departure and one representing a “distant” departure through Advisory Circular 91-53. The use of these procedures is dependent on the location of the specific noise-sensitive area that is to be avoided, and is most beneficial when a clear distinction between land uses (compatible versus non-compatible) exists. Due to conflicts between arriving and departing aircraft to the north of PHL (the area of significant impact), these procedures cannot be implemented, and are not further evaluated in this study.

Reducing noise levels created by arriving aircraft would involve managing the thrust, flap settings, and the timing of the deployment of the landing gear. Reducing airframe noise by modifying flap settings could require an aircraft increase speed to maintain level flight, thus increasing noise. Continuous descent approaches attempt to minimize thrust and flap settings to reduce noise exposure. Overall, the small potential gains in noise exposure would also have the potential to decrease the margin of safety of arriving aircraft at PHL, and are not recommended for further analysis.

Runways 09L/09R/17/35/08 NA Procedure (Alternative NA-U)

Noise abatement flight tracks have long been identified and used at PHL. The 2003 Part 150 included the evaluation of each of the departure flight tracks from all of PHL’s runways. Previously approved Measure NA-1, a continuation of existing conditions at the time of the 2003 FAR Part 150, stated “Aircraft weighing 12,500 pounds or more departing Runways 9L/9R/17/35/8 fly runway heading until reaching 2,000’ Above Ground Level.”

For aircraft departures to the east, north, or south departing from all runways except Runway 27L and 27R, aircraft weighing more than 12,500 pounds are directed to fly runway heading until reaching an altitude of 2,000 feet above the ground. This procedure applies to all aircraft except those weighing less than 12,500 pounds (generally, small single-engine propeller aircraft) and certain exempted aircraft, which begin their turns as instructed by ATCT.

Exempt aircraft include common turboprop and small jet passenger aircraft, including the Dash-7 (DH-7), Dash-8 (DH-8), Shorts 360 (SH36), Avion de Transport ATR 72 (AT4)2, AT72, BE02, Beech King Air 100 (BE10), Beech Super King Air (BE20), Beech Super King Air 300 (BE30), Saab 340 (SF34), Fairchild Swearingen Merlin 3 (SW3), Beechcraft 1900 (BA31), British Aerospace Jetstream 41 (BA41), Embraer 120 (E120), and Dornier 228 (DO82).

Once the aircraft reach their prescribed altitude, aircraft are directed to begin their turns towards a navigation fix or destination. Aircraft may not always follow these procedures, owing to weather patterns, safety, or ATCT instructions. This procedure represents the historical departure procedures in place at PHL. However, with the recommendations recently implemented (and those yet to be implemented) as a result of the ARD study, the times in which aircraft follow these procedures are limited from some runways. Namely, aircraft departures from Runways 09L and 09R are now prescribed to follow a set of dispersed headings. These dispersed headings are in use from 6:00 a.m. until 10:00 p.m. Outside of that window, the traditional procedures are followed for departures from Runways 09L and 09R. Aircraft weighing greater than 12,500 pounds departing Runways 17, 35, and 08 generally continue to follow the noise abatement procedure.

The use of this measure reduces the areas of overflight of noise-sensitive development and ensures that aircraft reach higher altitudes prior to turning towards a navigation fix or destination. Standard procedures for aircraft noise abatement departure procedures assist in the reduction of controller workload. With the implementation of multiple dispersed departure headings from Runways 09L and 09R, this noise abatement procedure is not utilized between 6:00 a.m. and 10:00 p.m. from these runways. This alternative was further evaluated as NA-1.
Runway 27L Noise Abatement Procedure (Alternative NA-V)

Previously approved Measure NA-2, a continuation of existing conditions at the time of the 2003 FAR Part 150, stated that “Aircraft weighing 12,500 pounds or more departing Runway 27L turn left to a 255 degree heading until reaching 3,000' Above Ground Level.”

This measure directs aircraft departing Runway 27L (to the west) weighing over 12,500 pounds and certain excepted aircraft to turn towards a designated heading over the Delaware River until reaching a prescribed altitude (3,000 feet AGL). This heading of 255-degrees places most jet aircraft over the Delaware River prior to beginning turns towards a navigation fix or destination. This procedure represents the historical departure procedures in place at PHL. However, with the recommendations recently implemented (and those yet to be implemented) as a result of the ARD study, the times in which aircraft follow these procedures are limited.

The use of this measure reduces the areas of overflight of noise-sensitive development and ensures that aircraft reach higher altitudes prior to turning towards a navigation fix or destination and reduces the direct overflight of noise-sensitive residents in Tinicum Township and areas further south and west the Delaware River. This alternative was further evaluated as NA-2.

Runway 27R Noise Abatement Procedure (Alternative NA-W)

The 2003 Part 150 evaluated the existing departure procedures from PHL’s main runways. Previously approved Measure NA-3, a continuation of existing conditions at the time of the 2003 FAR Part 150, stated “Aircraft weighing 12,500 pounds or more departing Runway 27R turn left to a 240 degree heading until reaching 3 DME, thence turn right to a 255 degree heading until reaching 3,000' Above Ground Level.”

Aircraft departing Runway 27R to the west weighing over 12,500 pounds and certain excepted aircraft, were directed to turn towards a designated heading over the Delaware River until reaching a prescribed altitude (3,000 feet AGL). However, because of separation requirements between aircraft departures from Runway 27L and 27R, aircraft must first fly a divergent heading of 240-degrees prior to adjusting course over the Delaware River. This heading of 255-degrees places most jet aircraft over the Delaware River prior to beginning turns towards a navigation fix or destination. This procedure represents the historical departure procedures in place at PHL.

However, with the recommendations recently implemented (and those yet to be implemented) as a result of the ARD study, the times in which aircraft follow these procedures are limited. With the implementation of the dispersed headings from Runway 27R, aircraft departures are now prescribed to follow a set of dispersed headings of either 260-degrees, 245-degrees, or 230-degrees (not yet implemented). This alternative was further evaluated as NA-3.

Maintenance Run-Up Restrictions (Alternative NA-X)

Limiting the duration and location of engine run-ups provides as much mitigation as possible without constructing an engine run-up enclosure or constructing a noise barrier along the perimeter of the airport. Limiting the location of engine maintenance run-ups to specific locations on the airfield can reduce potential ATCT and pilot confusion and thereby potentially increase safety. Because engine run-ups are performed occasionally at times when air traffic is low, some noise may be audible beyond the airport boundary. Many airports limit aircraft engine maintenance activity, such as:

- LaGuardia International Airport has promulgated a bulletin outlining engine run-up restrictions, which addresses engine maintenance run-ups, Auxiliary Power Unit (APU) use, and the movement of aircraft and vehicles associated with ground run-up activity. LGA publishes guidance regarding the locations in which aircraft engines may be tested (engine run-ups).
General Manager of LGA designates the locations on the airfield. The airport does not have a hush-house or ground run-up enclosure.

- John F. Kennedy International Airport also limits ground activity that could potentially disrupt neighbors or impact safety. According to published restrictions pertaining to engine run-ups, only run-ups in authorized areas (according to the Airport Duty Manager) are permitted, and no airline operator may perform run-ups of more than one aircraft at a time. During daytime hours (7:00 a.m. – 10:00 p.m.), no jet engine shall be run-up above “part power” (not exceeding 80% power) for more than one minute at a time and not more than one engine at a time, while during nighttime hours (10:00 p.m. – 7:00 a.m.), no jet engine can be run-up above “part power” for more than 30 seconds and not more than one engine at a time. No engine maintenance run-ups at full take-off power are permitted, either day or night.

The PHL ATCT maintains a log of run-up requests, indicating the location, requestor, aircraft type, time, duration, and reason for the run-up. Run-ups occur for reasons such as engine checks following maintenance, ongoing engine tests for aircraft undergoing service at PHL, or investigative issues. Engine run-ups are currently restricted to two locations on the airport – at the intersection of Taxiway K with Taxiway H (preferred location) with the aircraft facing east, and at the intersection of Taxiway P with Taxiway W, with the aircraft facing west. Engine run-ups require prior approval by Airport Operations and are limited to twenty (20) minutes duration. Between 11:00 p.m. and 6:00 a.m., run-ups are restricted unless failure to conduct the run-up will delay the departure of a scheduled flight. In addition, these run-ups are to be conducted at the preferred east location.

The 2003 Part 150 study recommended Measure NA-5, which stated “Continue existing run-up procedures providing for location and orientation preferences with requirements for pre-approval and limitation to 20 minutes or less.” Overall, analysis of engine run-up logs indicated consistency with the parameters of the original noise abatement measure. Due to the locations of the engine run-ups on the airfield, noise is not expected to cause notable intrusion beyond the limits of the airport property line. No changes or modifications to the noise abatement measure are recommended. This alternative was further evaluated as Measure NA-5.

**Noise Attenuation in New Building Construction (Alternative NA-Y)**

Throughout the PHL Master Plan process, Noise Abatement Measure NA-7, originally recommended in the 2003 Part 150 study, directs PHL to consider the potential of new airport development and its ability to reduce the transmission of ground noise. Individual building location and construction could potentially reduce the transmission of ground-based noise from aircraft as they taxi, deice, perform engine maintenance run-ups, or while idling at the gate. This alternative would direct the airport to consider the placement of buildings in ways to reduce noise exposure. In this case, buildings could have the same effect as other mitigation efforts, such as noise barriers or berms. This alternative was further evaluated as Measure NA-7.